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The Impact of Sex and Gender on Adaptation to Space: Commentary

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From the Microcosm of Space, sex and gender differences have an important impact on space exploration. Without an integrated focus on the impact of sex and gender on fundamental biology and clinical care, maintaining health during space missions could be compromised. This was the charge for a workshop sponsored by the National Aeronautics and Space Administration (NASA) and the University of Missouri in 2002 and a jointly supported NASA and National Space Biomedical Research Institute (NSBRI) decadal review and virtual workshop in 2013. Findings and recommendations for research priorities for sex and gender differences in six areas of medicine were once again provided during the 2013 review.

Regarding the recommendations that were developed during the 2002 workshop, NASA is making progress in the following areas: (1) improving the understanding of the influences of sex on how biological systems adapt to challenging environments such as microgravity, (2) developing a multi-agency initiative to fund interdisciplinary research relevant to sex differences in fundamental biology for studies conducted on board the International Space Station, (3) establishing a databank and research center for basic science and clinical observations and discoveries through the increased availability of the Longitudinal Survey of Astronaut Health, (4) implementing a policy to cover Assisted Reproductive Technology services for both male and female astronauts, (5) supporting analog environments for space flight such as in Antarctica, and (6) assessing the design of new space suits based on anthropometric measurements and movement in which sex can have impact.

While a decade has passed since the initial review and more individuals, human and animal, have participated in ground and flight-based studies and observations, there is still a paucity of data to make strong assertions about the impact of sex and gender on health outcomes. There are several reasons for this including (1) need for additional enforcement and oversight of the NASA and NSBRI policies on inclusion of men and women in trials which were based on the National Institutes of Health (NIH) policy on inclusion and adopted following the 2002 review, (2) lack of funding in basic and clinical research due to budgetary constraints, (3) lack of journal reviewers and editors requesting or publishing information regarding demographics such as sex when defining the populations being evaluated, (4) lack of segregated data by sex and gender and a tendency to pool data which would obscure the impact, and (5) lack of understanding of the definitions and usage of sex and gender which has become more complicated by the increased awareness of the influence of epigenetics.

Another challenge to overcome is changing the perspective that small numbers of participants in studies and flights do not provide relevant information that is useful towards shaping policies, procedures, and countermeasures to maintain health. This deeply entrenched belief that only statistical significance is relevant has minimized the impact of these findings. Acknowledging that the limitations of space flight on achieving statistical significance because of small numbers of participants and power do occur, NASA charged the Institute of Medicine (IOM) to address these concerns. The IOM found that through statistical and computational modeling, there is value in small numbers and NASA should not negate the importance of these findings. Additionally, NIH has addressed similar concerns in their policies on inclusion by sex and gender with the concept of ''valid analyses,'' which is highlighted in their policies for phase 3 studies. Understanding small differences is especially important in the extreme environment of space where even small differences in how the body adapts can translate into critical health outcomes.

An important recommendation from the 2002 review and again in the 2013 assessment was to encourage the development of educational and research training opportunities to nurture future generations of scientists and clinicians to think in terms of sex and gender similarities and differences in their approach to research and healthcare. Although the NIH and Food and Drug Administration have strongly encouraged this through their reports, conferences and policies, NASA has only recently increased its efforts in this area. Fortunately, through the activities of the private sector, including the Society for Women's Health Research, the Organization for the Study of Sex Differences, and the International Society for Gender Medicine, as well as other academically based programs, there has been momentum to achieve this goal.

NASA has promoted the development of the commercial space sector for the transport of payloads and eventually humans. As efforts continue, there should be an emphasis on the impact of sex and gender on the development of equipment, machine–human interfaces, and countermeasures

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including the use of personalized medicine and genomics or –‘‘astro-omics.’’ Through NASA’s collaboration with other agencies, industry, academia, and foundations and a focus on sex and gender, the highest level of medical care can be provided to ensure that astronauts are healthy in space and on Earth.

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